

# *Aviation Safety and Security Program*

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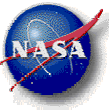
## **Training and Operations for Error Reduction**

Dr. Tina Beard

**Semi-Annual Meeting**

**NASA Glenn Research Center**

**September 24, 2003**



# Industry credibility

AvSSP

Threat & Human Error Management

## *Building the Foundation*

### **Built on review of 22 initiatives**

- ASIST
- Blueprint
- Safer Skies
- CPS
- CAST
- GA Joint Steering Committee
- JAA Joint Safety Strategy
- FAST
- FSF
- SAE Emerging Technologies
- AOPA
- CAPSTONE enhancement
- NTSB most wanted
- National EMS Pilots Ass.
- Helicopter Safety Advisory Conference
- European Aeronautics
- A Vision for 2020
- Eurocontrol ATM
- EECS R&D
- ACARE
- UK CAA
- UKOOK

*Most aviation accidents attributed to human error*

*Over 1/2 of the ASIST recommendations are HF concepts  
ASIST HF recommendations are still top priorities  
e.g., CAST top recommendations were in ASIST*

***Human Factors should not be buried in the Program***



# Accident Prevention Investment Areas

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## *The ASIST recommendations*

### **Category**

- ★ Digital Weather Product Dissemination
- ★ **Human/Task Metrics & Models for Evaluation**
- ★ Human/ Automation Design Principles and Guidelines
- ★ Aircraft Control in Adverse Conditions
- ★ **Crew/ Dispatch/ Wx Monitoring Presentation & Decision Making**
- ★ Task Selection and Training
- ★ Flight Deck Design and Integration
- ★ Icing Hazard Solutions
- ★ Advanced Vision and Sensor Technology
- ★ Advanced Containment Concepts for Engine Failure
- ★ Life Prediction, Modeling, & NDE
- ★ Skill Proficiency
- ★ Advanced Weather Products
- ★ Design, Verification, & Certification
- ★ Methods for Flight Critical Systems
- ★ FCSII Technology Integration, Validation, & Effective Transition
- ★ Design & Safety/Risk Assessment of Data Link Technologies
- ★ Rotorcraft-specific Pilot Aiding Systems
- ★ Aging Aircraft Systems
- ★ Maintenance Teamwork Procedures & Roles/Responsibilities
- ★ NAS Tools for Safety & Security
- ★ Advanced Aviation Meteorology
- ★ Health & Usage Monitoring Systems

### **Category**

- ★ Turbulence Hazard Solutions
- ★ Health Monitoring & Fault Diagnostics
- ★ Tactical Weather Sensors/ Systems
- ★ **Cultural Factors**
- ★ Fatigue and Circadian Disruption Impacts
- ★ Fault & Damage Tolerance
- ★ Human Selection & Training
- ★ Design Techniques for High-Integrity Complex Digital Systems
- ★ Rotorcraft-specific Procedures and Training
- ★ Structural Configurations and Aging Airframes/Engines
- ★ **Organizational Culture for Safety**
- ★ Safety & information security of flight operations in future NAS
- ★ Wake Vortex Hazard Avoidance
- ★ **Procedures Design Methods**
- ★ Design to support Teamwork
- ★ Weather Hazard Characterization
- ★ Cowl Fire Monitoring/Suppressant
- ★ Techniques in Post-Halon Era
- ★ Maintenance Training
- ★ Runway Contamination
- ★ Maintenance Task Procedures
- ★ Design to support Performance Readiness

*SWAP Phase I research areas mapped onto  
ASIST and CAST recommendations*



# Descriptive Narrative

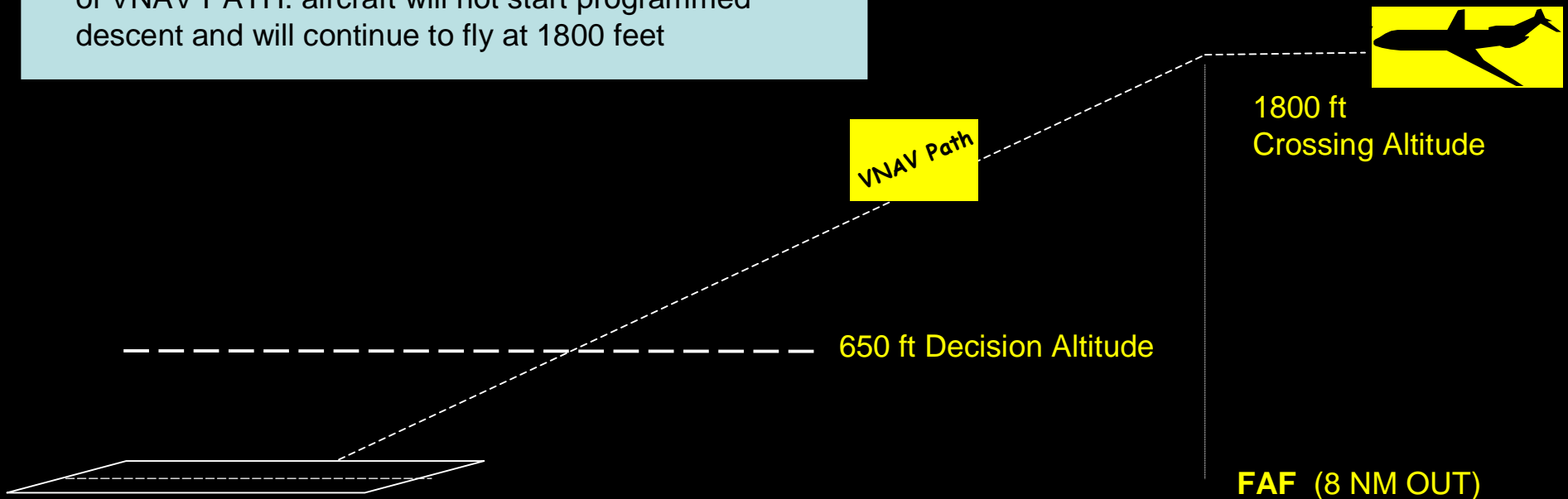
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High demand time in flight deck as pilots completing Before Landing Checklist while working to insure that aircraft is fully stabilized for landing

Prior to reaching FAF pilots must set DA in MCP or aircraft systems will switch to Altitude Hold and drop out of VNAV PATH: aircraft will not start programmed descent and will continue to fly at 1800 feet

## Visualization of 20 sec Segment of Flight Deck Activities

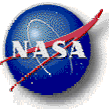


QuickTime™ and a  
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are needed to see this picture.

QuickTime™ and a  
Video decompressor  
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- When they notice their oversight do they land?
  - perception of risk
  - depends on safety culture
- normal and emergency or abnormal procedures can be evaluated
- procedural noncompliance
- conceptual automation training
- flight crew overload
- effects of distractions
- concurrent task management
- teach self-monitoring
- decision making under stress
- cognitive usability of flight deck technologies/design support tools
- integration of devices in cockpit
- alert and monitoring systems: Get a visual alert when pass FAF, illuminate, could have been avoided if aural alert alert
- system complexity
- train to multiple, ambiguous problems
- roles/responsibilities
- levels of automation

Thanks to Allen Goodman and Mike Delal for generating the MIDAS simulations for this presentation



# Work Breakdown Structure

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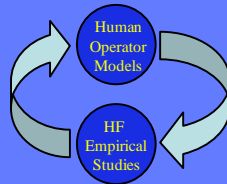
Threat & Human Error Management

## 728-07 Training and Operations for Error Reduction Threat and Human Error Management

### Cross-cutting Human Factors



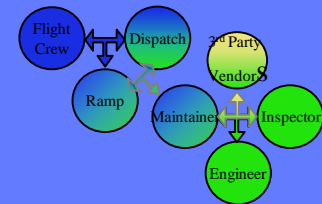
### Error & Risk Modeling



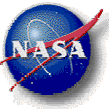
### Operational Error Mitigation



### Socio-technical Safety Management



**Develop means to assist operational personnel to detect and manage threats to flight safety**



# Cross-Cutting Human Factors Element

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*Threat & Human Error Management*

## Objective

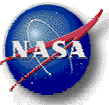
Develop implementable mitigation strategies based on accident and incident data to guide Program resource decisions and provide recommendations for certification of human-centered products.

## Products

- Human Factors recommendations
- Implementation route
  - Manuals and checklists
- Training aids

## Solution/Approach

- Event analysis research; e.g., ASRS, ASAP, NAOMS, NTSB, intra and inter-JSAT causal factors and intervention commonalities - leverage incident/accident data
  - Themes help guide research in Program
  - Feed Program assessments
  - ASRS improvements - automatic entry, need direct access
- Identify cross-cutting system-wide HF issues
  - ID Cross-cutting issues
  - Reviews (e.g., gaps in automation such as pilots confidence or time pressure
  - Expert knowledge solicitation - focus group - users, ATC, pilots, FAA on system integration and procedural issues
- Cross-cutting, Program-specific research
  - Based on above analysis
  - Obtain feedback from users in operational setting
- Ensure HF recommendations are utilized where feasible
  - Milestone links



# Event Analysis Research

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## Event analysis research

–Themes help guide research in Program; Feed Program assessments

- ASRS
- NASDAC
- NAOMS
- NTSB
- ASAP



**Get behind the Program projects**  
**Current trends in safety - what's missing**

*This training and experience informs our work on a daily basis*



GA experience



Military Experience



Flight instructors



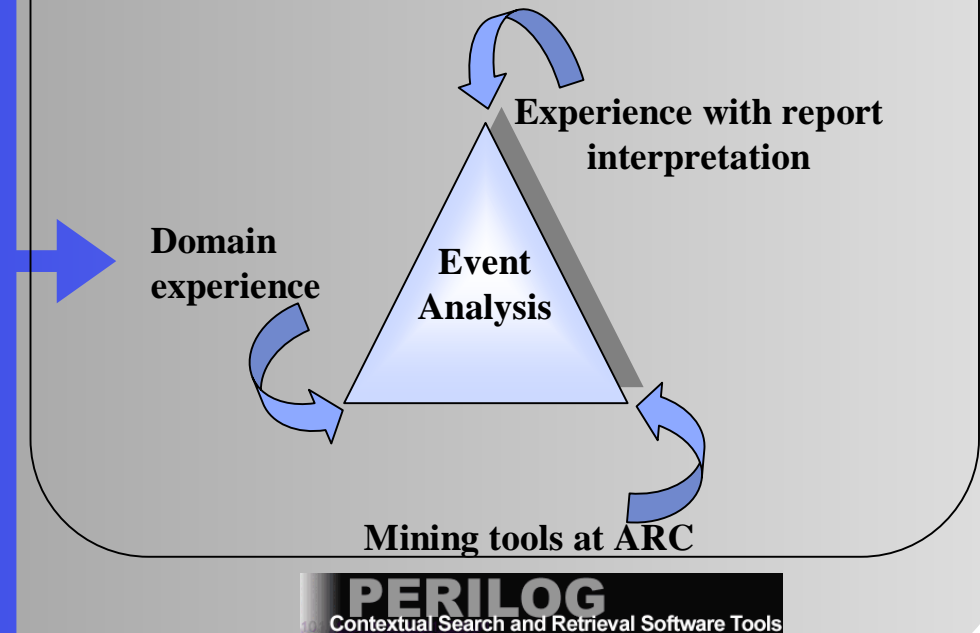
737 Type Ratings

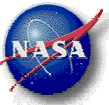
**Pilot Certificates held:**

Private  
Commercial  
Airline Transport



## Ames Unique Expertise with Event Analysis





# Cross-Cutting Human Factors Element

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*Threat & Human Error Management*

## Objective

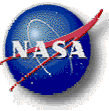
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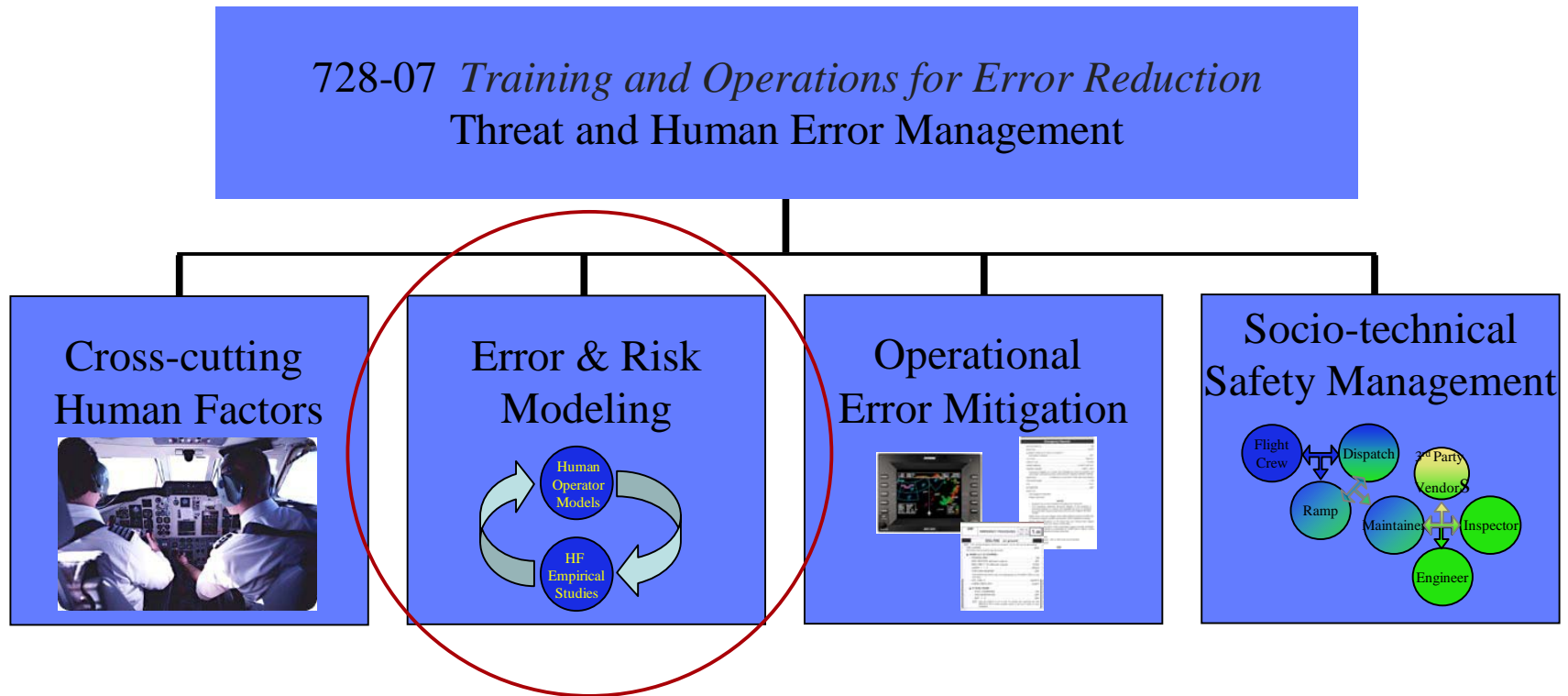
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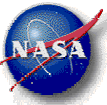
# Work Breakdown Structure

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Threat & Human Error Management



**Develop means to assist operational personnel to detect and manage threats to flight safety**



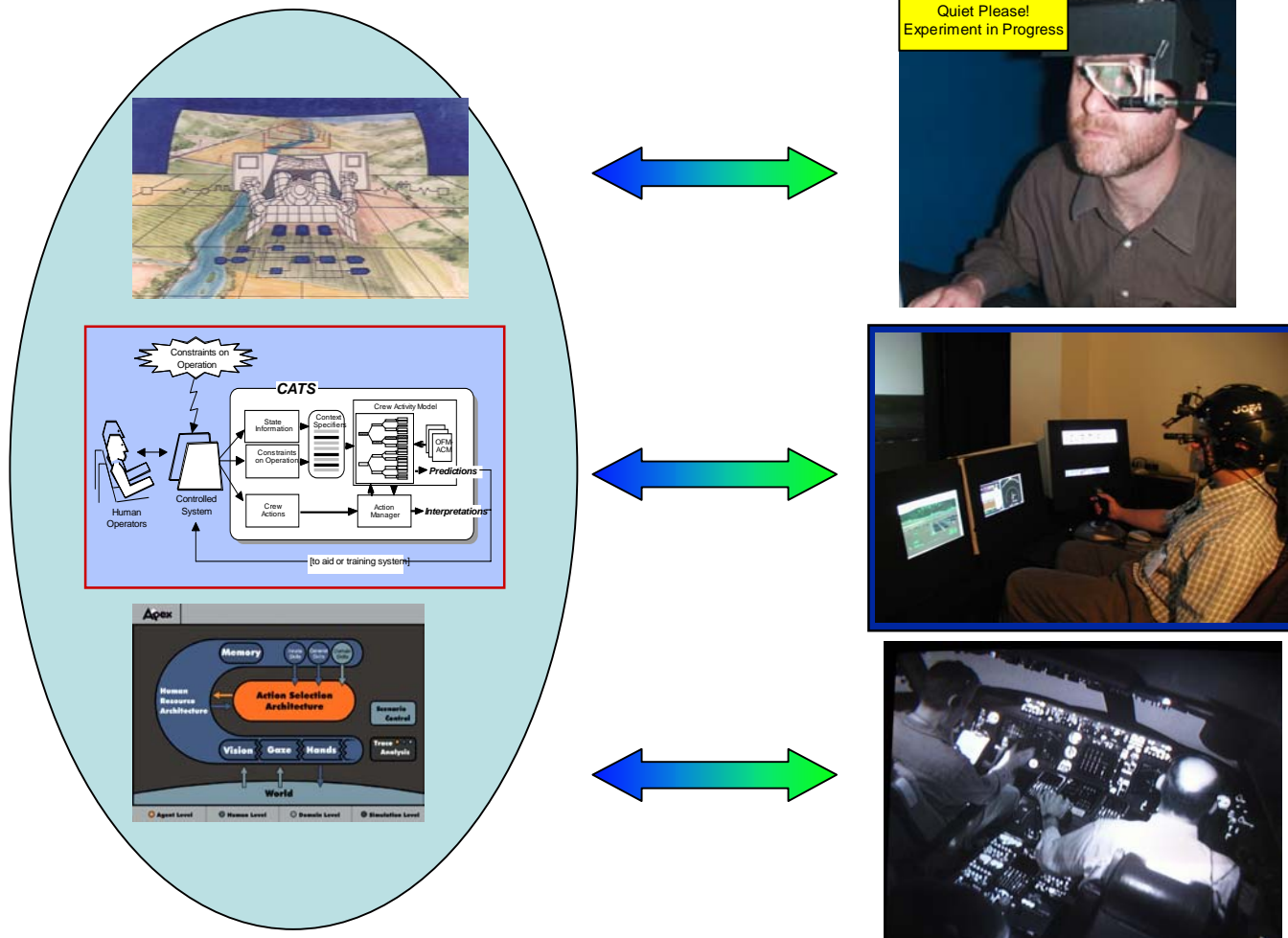
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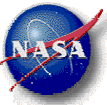
AvSSP

*Threat & Human Error Management*

**Develop means to assist operational personnel to detect and manage threats to flight safety**

- Determine corporate requirements for achieving and maintaining an organizational safety culture
- Develop guidelines, tools and metrics for managing errors and risks
- **Bring predictive capabilities to maturity**
- Improve human-machine interface and information transfer in socio-technical systems





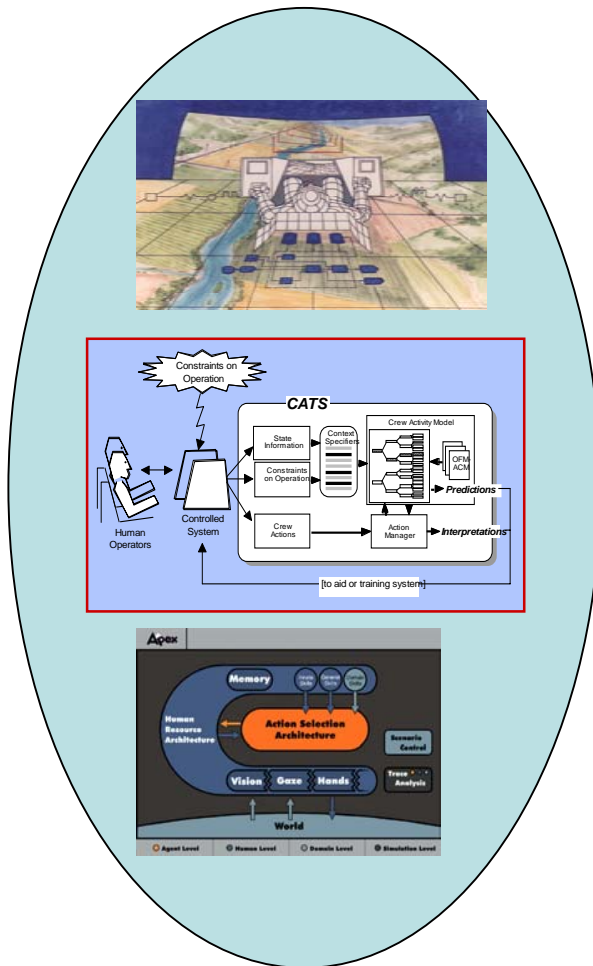
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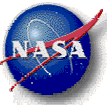
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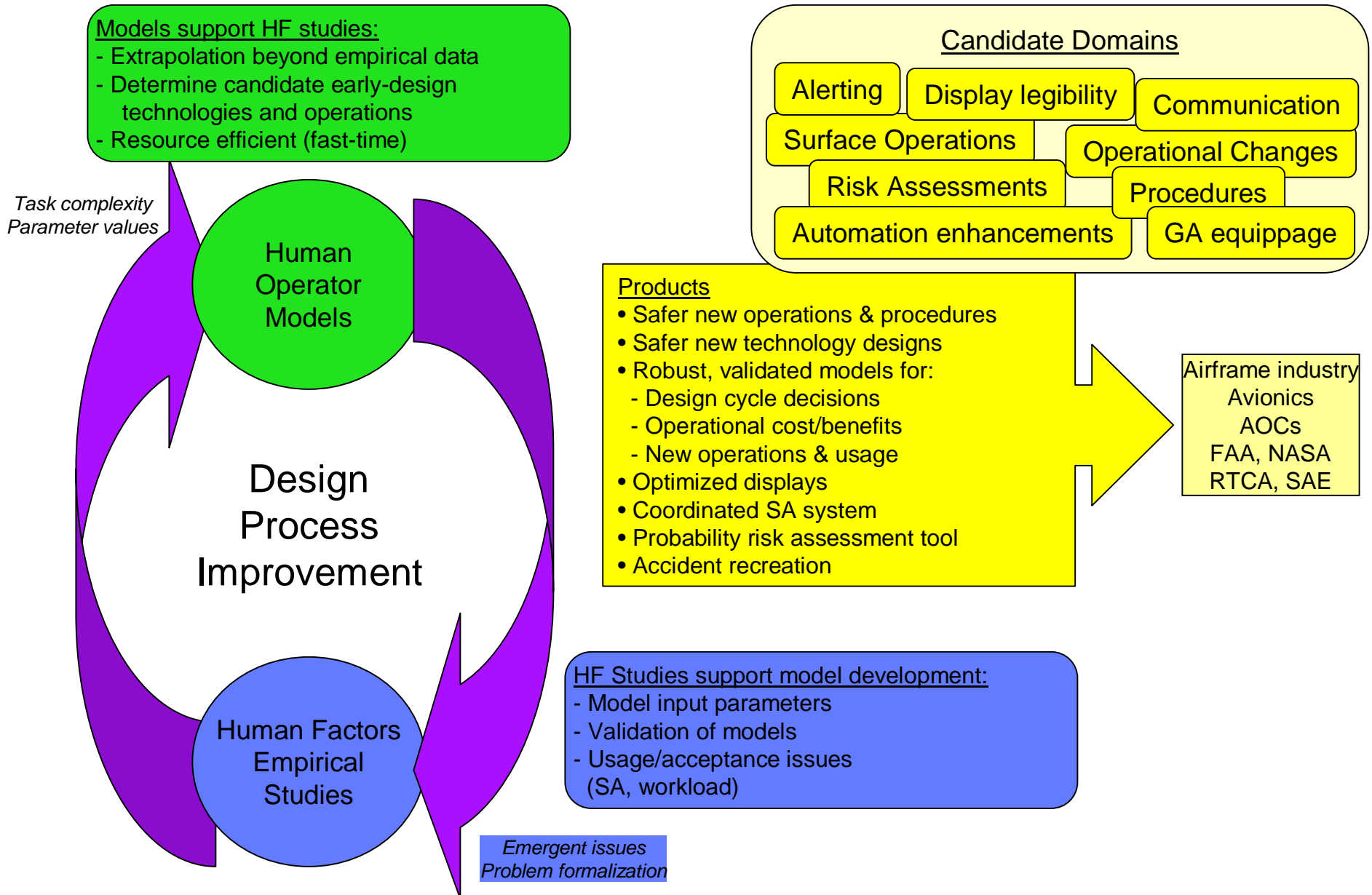




# Error & Risk Modeling (ERM) Element

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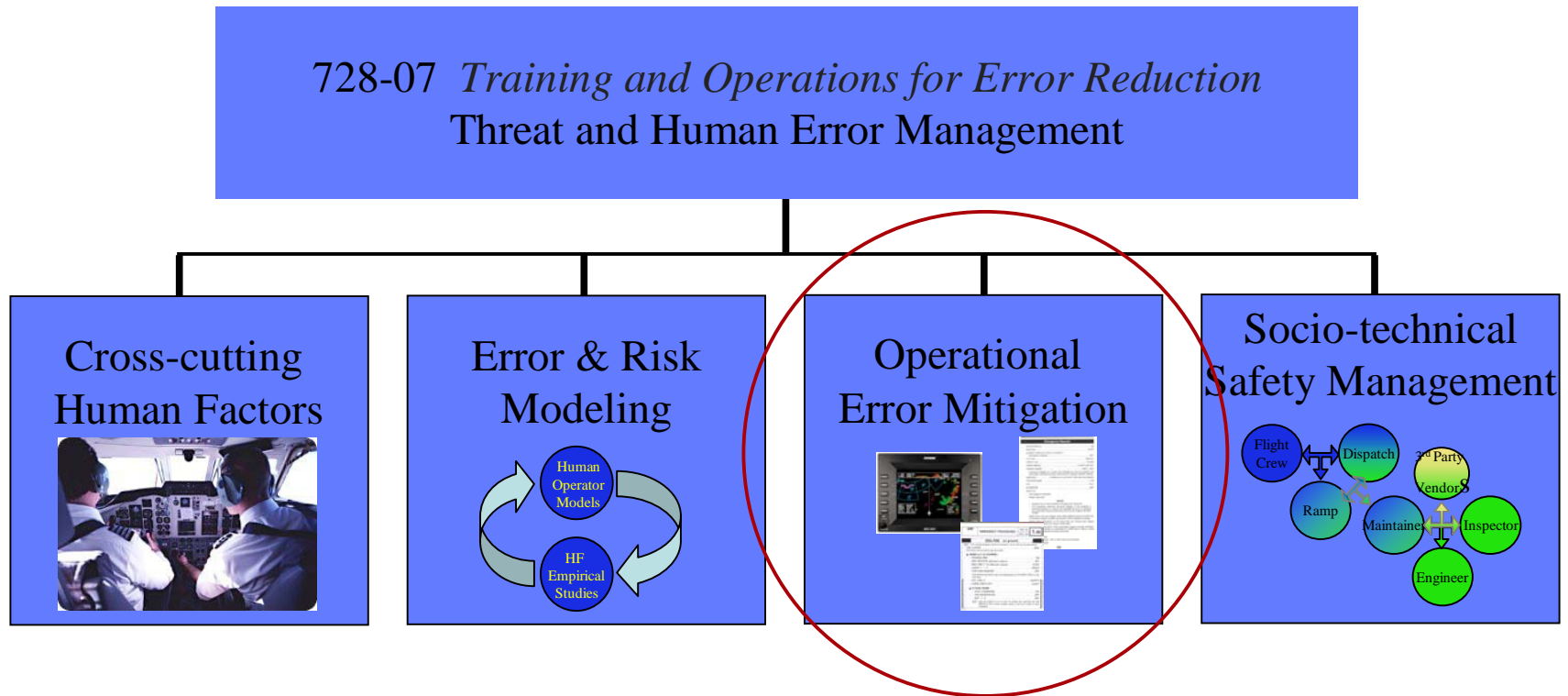




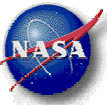
# Work Breakdown Structure

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Threat & Human Error Management



**Develop means to assist operational personnel to detect and manage threats to flight safety**



# Operational Error Mitigation (OEM) Element

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## Objective

Develop implementible mitigation strategies aiming at the roots underlying operational errors

## Solution/Approach

- Understand human cognitive vulnerabilities in operational contexts using empirical, field and simulation studies.
- Understand operational task demands
- Develop mitigating strategies
- Validate strategies and their implementibility
- Develop cross-operational applications (GA, Rotorcraft, Part 135, Part 121)

## Candidate Domains

Emergency & Abnormal situations  
Procedure development, Certification,  
Training, Alerts, Electronic checklists

Automation training

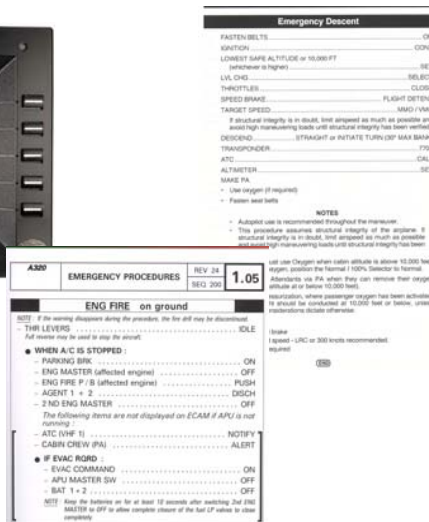
Interruptions

Communication

Concurrent task management

Flight crew overload

Decision making under stress



## Products

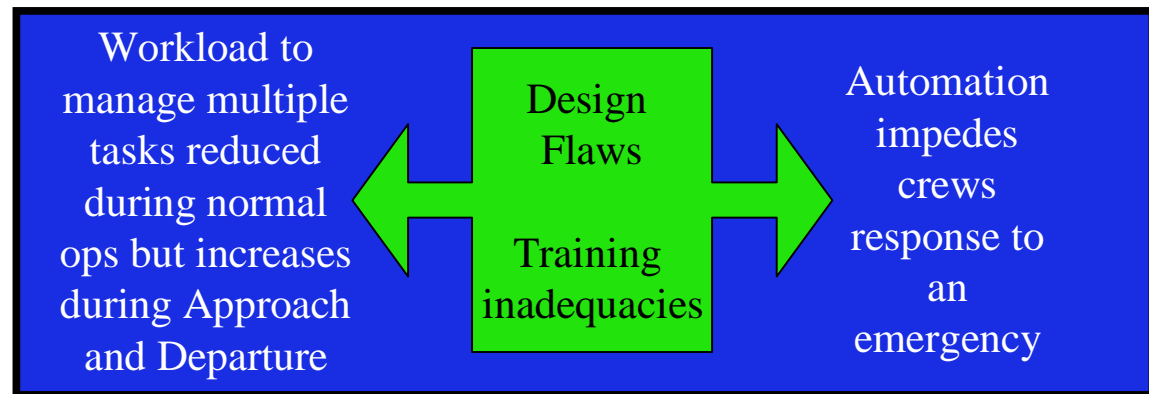
- Guidelines for the development, certification, and training for the evaluation of non-normal procedures
- Conceptual & procedural training textbook
- Effective use of alerts and monitoring in normal/abnormal conditions
- Guidelines toward harmonized procedures, communication that crosses org. and corp. boundaries
- Simulator Display Optimization
- Mitigation strategies for inattentional blindness and change blindness



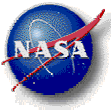
# A Proactive Approach to Error Free Human/Automation Interactions

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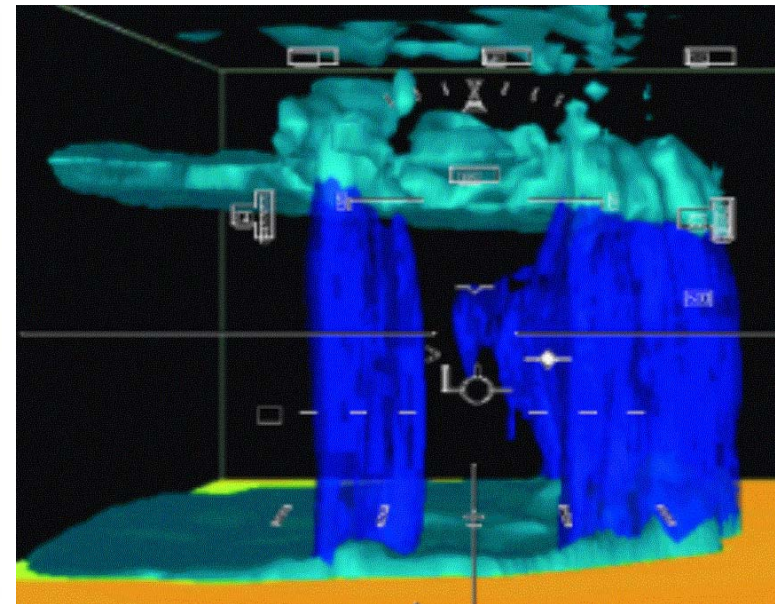
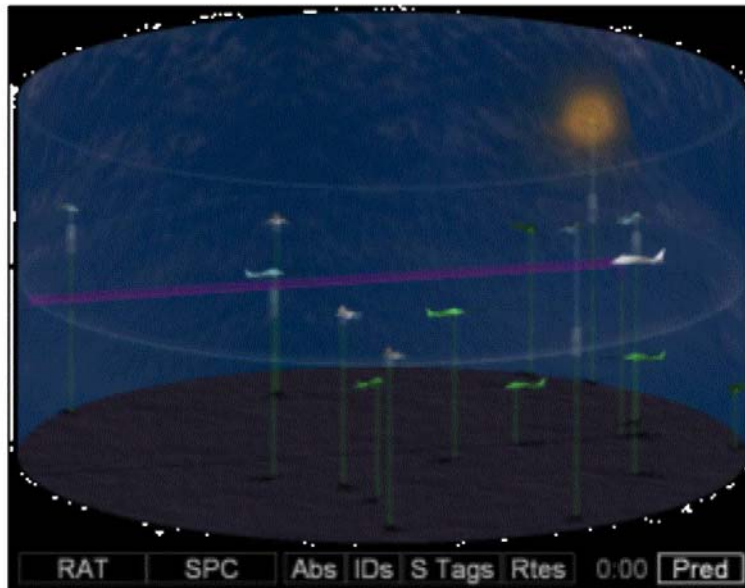
Time Critical Research  
Defined Implementation Route



## 3D Displays

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*Threat & Human Error Management*





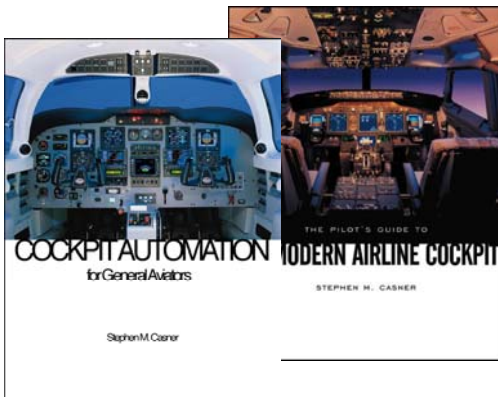
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AvSSP

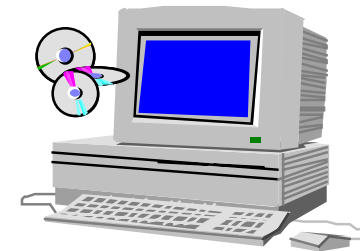
Threat & Human Error Management

**Develop means to assist operational personnel to detect and manage threats to flight safety**

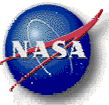
- Determine corporate requirements for achieving and maintaining an organizational safety culture
- **Develop guidelines, tools and metrics for managing errors and risks**
- Bring predictive capabilities to maturity
- Improve human-machine interface and information transfer in socio-technical systems



## INSTRUCTIONAL DVD



- Range of aircraft types
- Augment human abilities and minimize human limitations in next-generation NAS environment
- Maintenance of the aging fleet



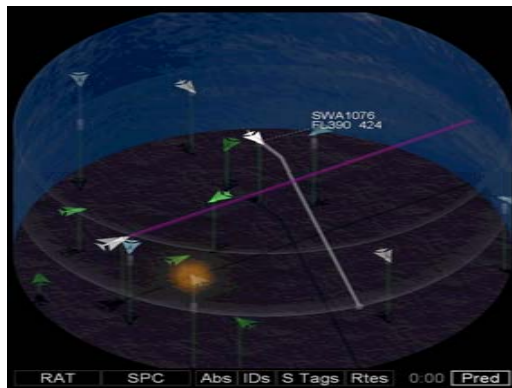
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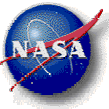
AvSSP

*Threat & Human Error Management*

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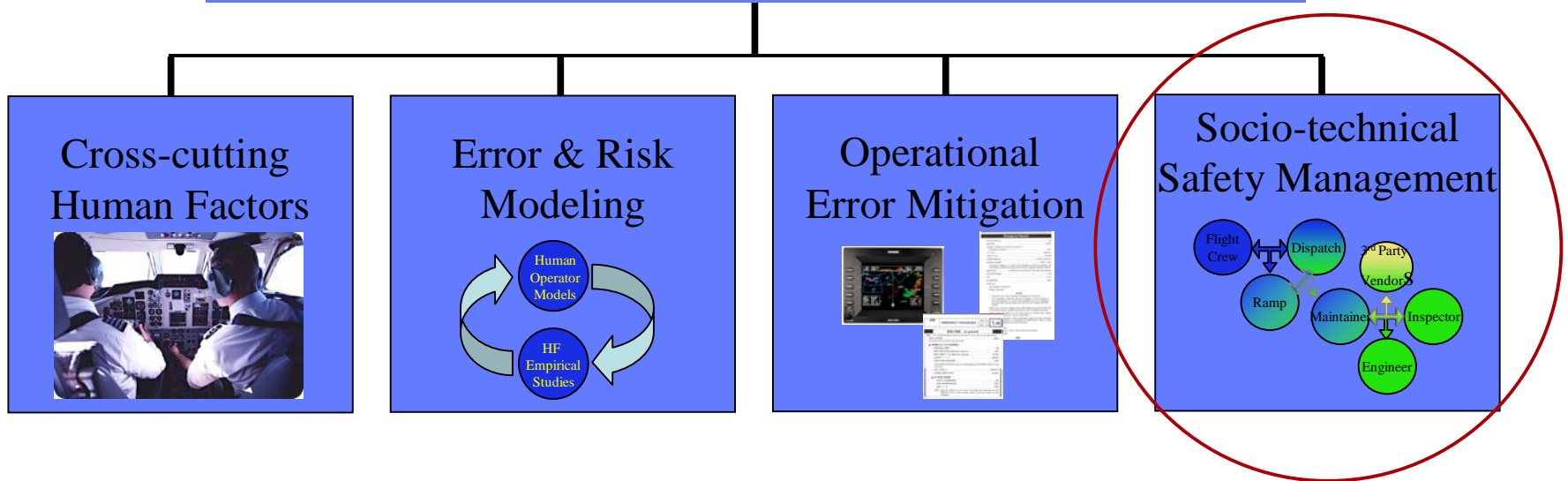


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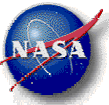
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Threat & Human Error Management

728-07 *Training and Operations for Error Reduction*  
Threat and Human Error Management



**Develop means to assist operational personnel to detect and manage threats to flight safety**



# Socio-technical Safety Management (StSM) Element

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Threat & Human Error Management

Aviation operations combine highly diversified social systems with complex technical systems which often involve a high level of automation and system dependencies. A socio-technical approach links these systems, always considering one in the context of the other.

## Objective

Develop tools for identifying, evaluating and mitigating socio-technical risk

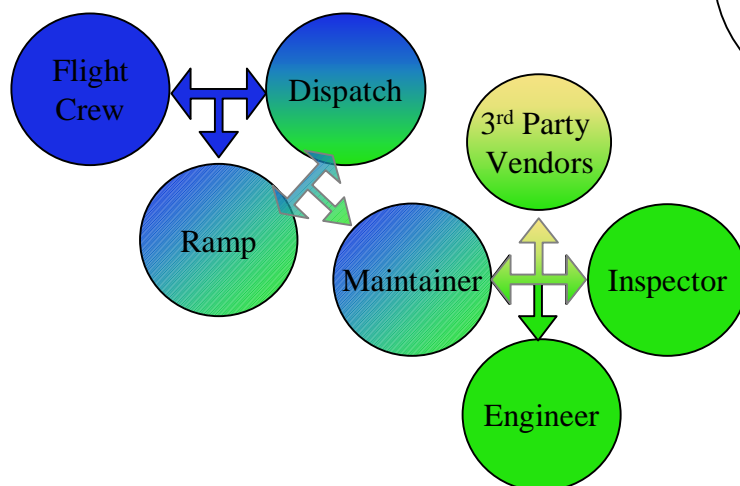
## Solution/Approach

### **Resolving Safety Culture Barriers**

- Define standard criteria for maintaining a just culture, a reporting culture, and a flexible culture that can learn from its errors.
- Develop guidance and training materials for managing normative risks in compliance-driven systems
- Build corporate-wide risk models that identifies ground-based pre-cursors to flight operational events

### **Knowledge Management Across Team Boundaries**

- Promote consistent knowledge management in a distributed information system; in which information content (terms, graphics, definitions), is standardized across organizations while serving the needs of each user community (e.g., flight operations, training, safety, maintenance, engineering, 3<sup>rd</sup> party vendors).
- Support and evaluate the implementation of technologies that enable cross-team collaboration and the use of shared, distributed information systems.
- Harmonize policies and procedures that cross organizational and corporate boundaries and promote one level of safety.

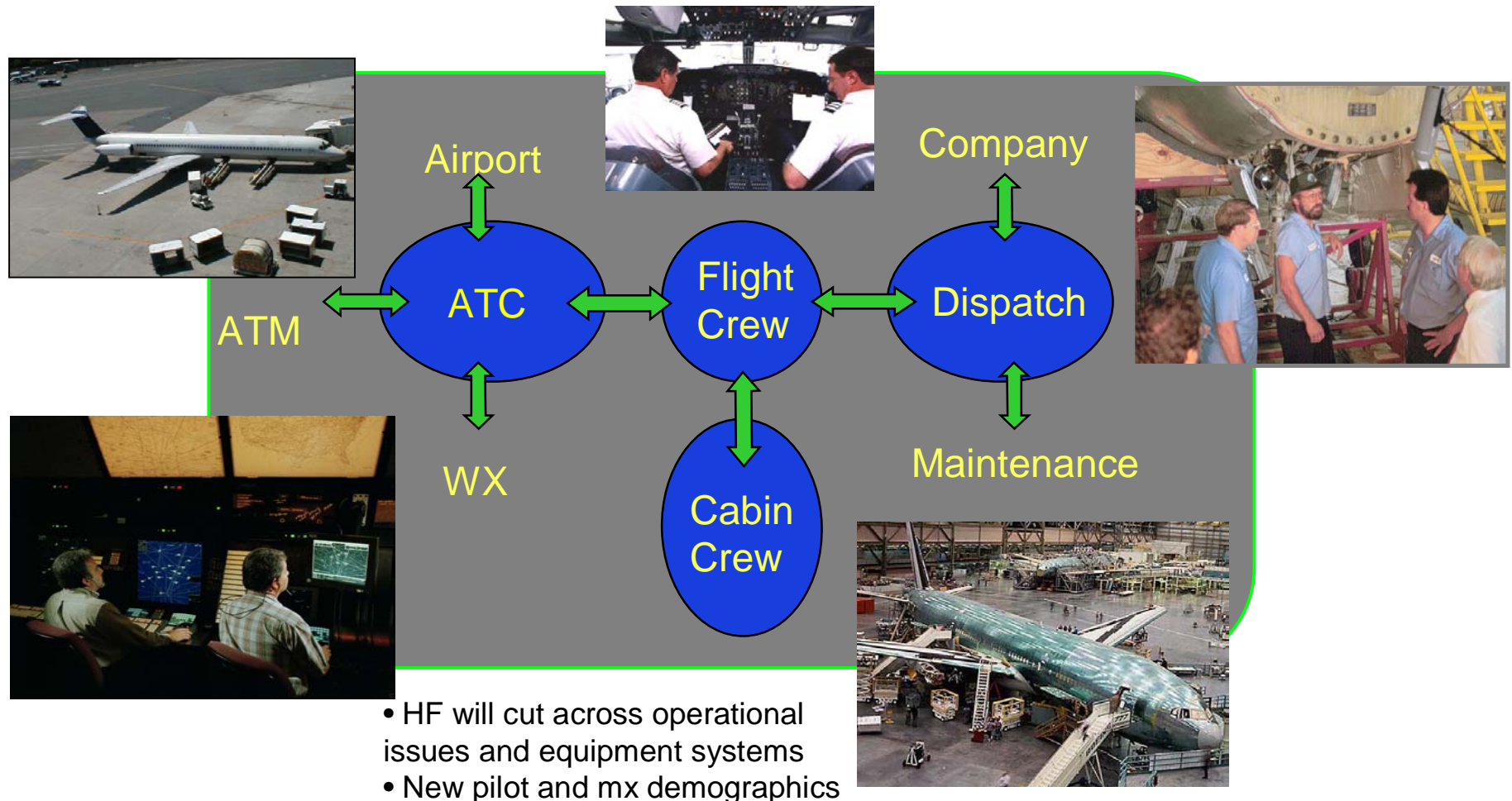


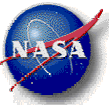
## Products

- Socio-technical approach, tools and strategies for corporate safety management, linking safety data and corrective actions
- Methods/metrics for monitoring & maintaining organizational safety culture health
- Identification and mitigation of corporate-wide at-risk behaviors and noncompliance
- Tools for managing corporate-wide risks and identifying dependencies between ground and flight operations
- Industry standards for digital data exchange, and the re-use of shared information across team and task boundaries



- **Determine corporate requirements for achieving and maintaining an organizational safety culture**
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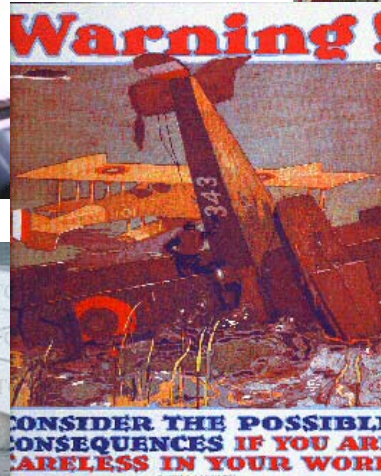
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AvSSP

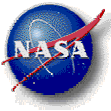
*Threat & Human Error Management*

## **Develop means to assist operational personnel to detect and manage threats to flight safety**

- Determine corporate requirements for achieving and maintaining an organizational safety culture
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Precursor risk assessment -  
not just past accident and incident data



# Project WBS

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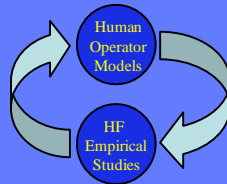
Threat & Human Error Management

728-07 *Training and Operations for Error Reduction*  
Threat and Human Error Management (THEM)

Cross-cutting  
Human Factors



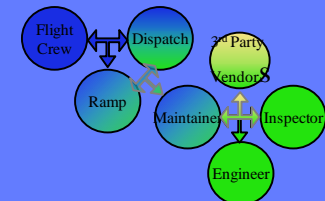
Error & Risk  
Modeling



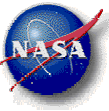
Operational  
Error Mitigation



Socio-technical  
Safety Management



Project (9/20/03)	2006	2007	2008	2009	2010	2011
Total	\$8.143M	\$8.767M	\$8.880M	\$8.917M	0.000M	0.000M
Proc	\$5.291M	\$5.743M	\$5.212M	\$4.400M	\$0.000M	\$0.000M
Non-Proc	\$2.852M	\$3.024M	\$3.668M	\$4.517M	0.000M	\$0.000M
Required Procurement For Proposed Work	\$12.41M	\$10.6M	\$11.8M	\$10.4M	\$10.4M	\$12M

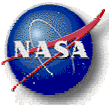


# Summary of Approach and Focus

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*Threat & Human Error Management*

- Blend of revolutionary technologies, as well as retrofit
- Balance from base to revolutionary
- HF will cut across operational issues and equipment systems
- All aircraft types
- Augment human abilities and minimize human limitations in next-generation NAS environment
- Maintenance of the aging fleet
- New pilot demographics
- Precursor risk assessment - not just past accident and incident data
- **Distinct beginnings and endings to projects**
- **Timely delivery of turn-key products to industry customers (readily incorporate into flight ops at low cost)**
- **Products throughout course of program**
- **Quality participation from FAA, DoD, industry, and academia**
- **Combines ASIST on-going with ASIST previously below-the-line**
























# Accident Prevention Investment Areas

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Threat & Human Error Management

## *The ASIST recommendations*

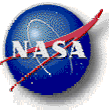
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-  Human/ Automation Design Principles and Guidelines
-  Aircraft Control in Adverse Conditions
-  **Crew/ Dispatch/ Wx Monitoring Presentation & Decision Making**
-  Task Selection and Training
-  Flight Deck Design and Integration
-  Icing Hazard Solutions
-  Advanced Vision and Sensor Technology
-  Advanced Containment Concepts for Engine Failure
-  Life Prediction, Modeling, & NDE
-  Skill Proficiency
-  Advanced Weather Products Design, Verification, & Certification
-  Methods for Flight Critical Systems
-  FCSII Technology Integration, Validation, & Effective Transition
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-  Advanced Aviation Meteorology
-  Health & Usage Monitoring Systems

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-  Turbulence Hazard Solutions
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-  **Cultural Factors**
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-  Fault & Damage Tolerance
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-  Cowl Fire Monitoring/Suppressant Techniques in Post-Halon Era
-  Maintenance Training
-  Runway Contamination
-  Maintenance Task Procedures
-  Design to support Performance Readiness

*TEM Phase II and SWAP Phase I research areas mapped onto ASIST and CAST recommendations*



# Future Aviation Safety Team

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Threat & Human Error Management

## *Top 20 Areas of Change Affecting Aviation (Prioritized)*

- ★ Reliance on flight deck automation
- ★ Emergence of new concepts for airspace management
- ★ Introduction of new technologies with unforeseen human factors aspects
- ★ Proliferation of heterogeneous aircraft with widely-varying equipment and capabilities
- ★ Discrepancies in pace and approach in development and implementation of airborne versus ground-based technology systems
- ★ Increasing number of aviation operations (Capacity)
- ★ Variation of sophistication of hardware and software within an individual aircraft type
- ★ Aging avionics, power-plants, electrical and mechanical systems, and structures
- ★ Lack of qualified maintenance personnel
- ★ Decrease separation standards (Capacity)
- ★ Incentives to outsource aircraft maintenance
- ★ Pressure for standardization of cockpit controls, displays, and automated systems interfaces among aircraft
- ★ Shift in responsibility for collision avoidance from ATC to crew
- ★ Information inequality among aviation system participants in situations requiring shared decision making
- ★ Reliance on active flight controls
- ★ Increasing numbers of aircraft operations at lower altitude and/or in adverse weather conditions
- ★ Maintenance complexity for next generation integrated aircraft
- ★ Discrepancies in the pace and direction of development of ground versus in-flight CNS systems
- ★ Lack of maintenance expertise among operators and outsource providers

*TEM Phase II and SWAP Phase I research  
areas mapped onto FAST recommendations*